PU030052 (JP2001244968) ON 8459

(19) Patent Agency of Japan (JP)
(12) Official report on patent publication (A)
(11) Publication number: 2001-244968
(43) Date of publication of application: 07.09.2001
(51) Int.Cl. H04L 12/56 H04L 12/46 H04L 12/28 H04L 29/08
(21) Application number: 2000-050699
(22) Date of filing: 28.02.2000
(71) Applicant: Nippon Telegr & Teleph Corp <NTT>
(72) Inventor: Kawahara Ryoichi, Hirano Satoyuki, Komatsu Naohisa
(54) Title of the invention: Packet transfer rate determining method and packet transfer device

(57) Abstract:

Problem to be solved: To provide a packet transfer rate determining method and a packet transfer device, with which bands can be equally distributed to the respective users of the Internet.

Solution: In an internal node, the active user flow number of a class (i) is updated by Fi? (1-a)*Fi+a*Ai/Gi, and a packet transfer rate from the buffer of the class (i) is updated by Di=(Fi*Gi/SFi*Gi)*C, where Ai is arrival rate, Gi is

guarantee band, (a) is parameter and C is link rate. Besides, when the number of packets to be transferred in the internal node exceeds a threshold, a packet transfer rate Di from the buffer of that class (i) is increased by Di? Di+d, and a packet transfer rate Dj from the buffer of a class (j) having the minimum value of Qi is decreased by Dj? Dj-d. In place of the number of packets to be transferred, the loss rate of packets in the buffer of the class (i) inside the internal node can be used as well.

[Claims]

[Claim 1]

Providing a class of service for every warranted band to each user, and a packet from a user is received in a boundary node of a communications network, with reference to a class of service to which the user belongs, marking of the class value is carried out to the packet, it is an internal node, when comparing a band and a warranted band of the packet, having exceeded a warranted band, carrying out tagging to the packet and transmitting a packet to an inside of a communications network, in a method of forming a buffer according to class of service for every output link, and determining a packet transfer rate impartially corresponding to each class, the arrival rate Ai (bps) of a packet by which tagging is not belonged and carried out to the class i among packets that reached

an internal node is measured in the predetermined time intervals t (s), when Gi (bps) is made into a warranted band of the class i and a is made into a smoothing parameter, when the number Fi of active user flows of the class i is updated by Fi<-(1-a) * Fi+a * Ai/Gi and C (bps) is made into an output link rate, predetermined cycle T (s) every packet transfer rate determining method updating the packet transfer rate Di (bps) from a buffer of the class i by Di=(Fi * Gi/S Fi * Gi) * C.

[Claim 2]

Providing a class of service for every warranted band to each user, and a packet from a user is received in a boundary node of a communications network, with reference to a class of service to which the user belongs, marking of the class value is carried out to the packet, it is an internal node, when comparing a band and a warranted band of the packet, having exceeded a warranted band, carrying out tagging to the packet and transmitting a packet to an inside of a communications network, in a method of forming a buffer according to class of service for every output link, and determining a packet transfer rate impartially corresponding to each class, when the arrival rate Ai (bps) of a packet of the class i was measured in the predetermined time intervals t (s) among packets that were alike and arrived to an internal node, Gi (bps) is made into a warranted band of the class i and a is

made into a smoothing parameter, when the number Fi of active user flows of the class i is updated by Fi<-(1-a) * Fi + a * Ai/Gi and an output link rate is set to C (bps), predetermined cycle T (s) every packet transfer rate determining method updating the packet transfer rate Di (bps) from a buffer of the class i by Di=(Fi * Gi/S Fi * Gi) * C.

[Claim 3]

Providing a class of service for every warranted band to each user, and a packet from a user is received in a boundary node of a communications network, with reference to a class of service to which the user belongs, marking of the class value is carried out to the packet, it is an internal node, when comparing a band and a warranted band of the packet, having exceeded a warranted band, carrying out tagging to the packet and transmitting a packet to an inside of a communications network, in a method of forming a buffer according to class of service for every output link, and determining a packet transfer rate impartially corresponding to each class, the number Qi of packets by which tagging is not carried out among packets that are waiting for transmission within a buffer of the class i in an internal node is managed, when a packet of the class i arrives, Qi exceeds threshold Th defined preliminary and it is considered as a part for rate increase and decrease that was able to define d (bps) preliminary, the packet transfer rate Di (bps) from a

buffer of the class i is made to increase by Di<-Di+d, a packet transfer rate determining method decreasing the packet transfer rate Dj (bps) from a buffer of the class j with the smallest value of Qi by Dj<-Dj-d.

[Claim 4]

Providing a class of service for every warranted band to each user, and a packet from a user is received in a boundary node of a communications network, with reference to a class of service to which the user belongs, marking of the class value is carried out to the packet, it is an internal node, when comparing a band and a warranted band of the packet, having exceeded a warranted band, carrying out tagging to the packet and transmitting a packet to an inside of a communications network, in a method of forming a buffer according to class of service for every output link, and determining a packet transfer rate impartially corresponding to each class, when the packet number Qi that waits for transmission within a buffer of the class i in an internal node is managed, a packet of the class i arrives, Qi exceeds threshold Th defined preliminary and it is considered as a part for rate increase and decrease that was able to define d (bps) preliminary, the packet transfer rate Di (bps) from a buffer of the class i is made to increase by Di<-Di+d, a packet transfer rate determining method decreasing the packet transfer rate Dj (bps) from a buffer of the class j with the smallest value of Qi by Dj<-Dj-d.

[Claim 5]

Providing a class of service for every warranted band to each user, and a packet from a user is received in a boundary node of a communications network, with reference to a class of service to which the user belongs, marking of the class value is carried out to the packet, it is an internal node, when comparing a band and a warranted band of the packet, having exceeded a warranted band, carrying out tagging to the packet and transmitting a packet to an inside of a communications network, in a method of forming a buffer according to class of service for every output link, and determining a packet transfer rate impartially corresponding to each class, the loss rate Li of a packet in a buffer of the class i in an internal node by which tagging is not carried out is measured with a predetermined cycle, the packet transfer rate Di (bps) from a buffer of the class i with the largest value of the loss rate Li is made to increase by Di<-Di+d, a packet transfer rate determining method decreasing the packet transfer rate Dj (bps) from a buffer of the class j with the smallest value of Li by Dj<-Dj-d.

[Claim 6]

Providing a class of service for every warranted band to each user, and a packet from a user is received in a boundary node of a communications network, with reference to a class of service to which the user

belongs, marking of the class value is carried out to the packet, it is an internal node, when comparing a band and a warranted band of the packet, having exceeded a warranted band, carrying out tagging to the packet and transmitting a packet to an inside of a communications network, in a method of forming a buffer according to class of service for every output link, and determining a packet transfer rate impartially corresponding to each class, the loss rate Li of a packet in a buffer of the class i in an internal node is measured with a predetermined cycle, the packet transfer rate Di (bps) from a buffer of the class i with the largest value of the loss rate Li is made to increase by Di<-Di+d, a packet transfer rate determining method decreasing the packet transfer rate Dj (bps) from a buffer of the class j with the smallest value of Li by Dj<-Dj-d.

[Claim 7]

The packet transfer device including a means to measure a traffic state of the class i with a packet transfer rate determining method according to claims 1 - 6, and a means to change dynamically a packet transfer rate from a buffer of the class i, providing a class of service for every warranted band to each user, and a packet from a user is received by a boundary node of a communications network, with reference to a class of service to which the user belongs, marking of the class value is carried out to the packet, it is an

internal node when comparing a band and a warranted band of the packet, carrying out tagging to the packet when a warranted band is exceeded, and transmitting a packet to an inside of a communications network, in a device that is provided with a buffer according to class of service for every output link, determines a packet transfer rate impartially corresponding to each class and transmits a packet.

[Detailed description of the invention]

[0001]

[Field of the invention] This invention relates to Diffserve that is the service which guarantees the quality of service of Internet communication.

[0002]

[Description of the prior art] Diffserve is examined in order to offer the quality of service guarantee of a throughput guarantee in the Internet. In Diffserve, a class of service is provided for every warranted band to each user, in the boundary node and in an internal node of a communications network, receiving the packet from a user and marking of the class value is carried out to the packet with reference to the class of service to which the user belongs, comparing the band and warranted band of the packet, when having exceeded the warranted band, carry out tagging to the packet, transmit a packet to the inside of a

communications network. The buffer according to class of service or the packet discarding threshold according to class of service is established for every output link and a packet transfer rate is impartially determined corresponding to each class.

[0003] Namely, as existing buffering technology in the internal node of Diffserve, there are CBQ (Class Based Queuing) that performs buffering for every class of service, and WRED (Weighted Random Early Detection) that provides a different packet discarding threshold for every class of service in a FIFO buffer. However, these methods are insufficient for determining a fair transfer rate.

[0004] For this reason, although it is possible to offer a weighting throughput guarantee to each user flow on the assumption that the Diffserve architecture, in that case, it is necessary to assume traffic conditions (here the number of active flows or the number mixture ratio of flows of each class), and to set the parameter used for each control with the mentioned above existing technology. Thus, when it changes with the traffic conditions which the traffic conditions under employment assumed, a weighting throughput guarantee may be unable to be realized.

[0005] This is explained using drawing 1. In drawing, 101 - 104 is a boundary node, 111, 112 is an internal node, 121 is TCP connection of the class 1, 122 is

TCP connection of the class 2, 123, 124 is TCP connection, 131-134 is a terminal unit, 141 is the buffer of the class 1, 142 is the buffer of the class 2.

[0006] Now for example, a warranted band between the internal node 111 and the internal node 112 with the buffers 141, 142 according to class with which the user flows 121, 122 of the class 1 that is G1=200k bps, and the G2=100k bps class 2 perform CBQ. It is assumed that the link 151 of stretched C=3Mbps is shared. Here, the number of active flows of the class 1 and the class 2 is set to N1 and N2, respectively, and it assumes that N1=N2=10, and suppose the packet transfer rate Di from the class i that it was decided that they would be D1=2Mbps and D2=1Mbps by Di=(Ni * Gi/S Ni * Gi) *C. If it is as the number of active flows having assumed, the band belonging to the class 1 and the class 2 per one user will be set to (2Mbps/10 user)=200k bps and (1Mbps/10 user) =100k bps, respectively, it is realizable of a weighting throughput guarantee.

[0007] Also, when changing into N1=N2=5, the banf belonging to the class 1 and the class 2 per one user is set to (2Mbps/5 user)=400k bps and (1Mbps/5 user) =200k bps, respectively, the throughput for a warranted band can be guaranteed to every user, and the throughput of the user of the class 1 becomes twice a throughput of the user of the class 2, and

weighting corresponding to a warranted band can be achieved.

[0008] However, when changing into N1=5 / N2=20, for example, the band belonging to the user of the class 1 and the class 2 per one user is set to(2Mbps/5 user) =400k bps and (1Mbps/20 user) =50k bps, respectively, the throughput for a warranted band is not given to the user of the class 2, but also, it will be 4 times the class 2, a band is superfluously assigned to the class 1, and unfairness produces the throughput of the user of the class 1. If traffic conditions are changed also in WRED that sets up a plurality of thresholds by a FIFO buffer, a threshold may become unsuitable and the same problem may arise.

[0009]

[Problems to be solved by the invention] The purpose of this invention by securing each user the throughput for a warranted band, and offering the weighting throughput guarantee corresponding to a warranted band in view of the mentioned above problem, it is in providing the packet transfer rate determining method and packet transfer device that can perform fair band distribution.

[0010]

[Means for solving the problem] In order to achieve the mentioned above purpose, the 1st packet transfer rate determining method of this invention, the arrival

rate Ai (bps) of a packet by which tagging is not belonged and carried out to the class i among packets that reached an internal node is measured in the predetermined time intervals t (s), when Gi (bps) is made into a warranted band of the class i and a is made into a smoothing parameter, when the number Fi of active user flows of the class i is updated by Fi<-(1-a) *Fi + a * Ai/Gi and an output link rate is set to C (bps), predetermined cycle T (s) every packet transfer rate Di (bps) from a buffer of the class i is updated by Di=(Fi * Gi / S Fi * Gi) * C.

[0011] The 2nd packet transfer rate determining method of this invention, when the arrival rate Ai (bps) of a packet of the class i was measured in the predetermined time intervals t (s) among packets that reached an internal node, Gi (bps) is made into a warranted band of the class i and a is made into a smoothing parameter, when the number Fi of active user flows of the class i is updated by Fi<-(1-a) * Fi+a * Ai/Gi and an output link rate is set to C (bps), predetermined cycle T (s) every packet transfer rate Di (bps) from a buffer of the class i is updated by Di=(Fi * Gi / S Fi * Gi) * C.

[0012] The 3rd packet transfer rate determining method of this invention, the number Qi of packets that has not exceeded a warranted band among packets that are waiting for transmission within a buffer of the class i in an internal node is managed,

when a packet of the class i arrives, Qi exceeds threshold Th defined preliminary and it is considered as a part for rate increase and decrease that was able to define d (bps) preliminary, the packet transfer rate Di (bps) from a buffer of the class i is made to increase by Di<-Di+d and the packet transfer rate Dj (bps) from a buffer of the class j with the smallest value of Qi is then decreased by Dj<-Dj-d.

[0013] The 4th packet transfer rate determining method of this invention, when the packet number Qi that waits for transmission within a buffer of the class i in an internal node is managed, a packet of the class i arrives, Qi exceeds threshold Th defined preliminary and it is considered as a part for rate increase and decrease which was able to define d (bps) preliminary, the packet transfer rate Di (bps) from a buffer of the class i is made to increase by Di<-Di+d and the packet transfer rate Dj (bps) from a buffer of the class j with the smallest value of Qi is then decreased by Dj<-Dj-d.

[0014] The 5th packet transfer rate determining method of this invention, the loss rate Li of a packet that has not exceeded a warranted band in a buffer of the class i in an internal node is measured with a predetermined cycle, the packet transfer rate Di (bps) from a buffer of the class i with the largest value of the loss rate Li is made to increase by Di<-Di+d, and the packet transfer rate Dj (bps) from a buffer of the

class j with the smallest value of Li is decreased by Dj<-Dj-d.

[0015] The 6th packet transfer rate determining method of this invention, the loss rate Li of a packet in a buffer of the class i in an internal node is measured with a predetermined cycle, the packet transfer rate Di (bps) from a buffer of the class i with the largest value of the loss rate Li is made to increase by Di< -Di+d, and the packet transfer rate Dj (bps) from a buffer of the class j with the smallest value of Li is decreased by Dj<-Dj-d.

[0016] A packet transfer device of this invention possesses a means to measure a traffic state of the class i with either of the mentioned above packet transfer rate determining methods, and a means to change dynamically a packet transfer rate from a buffer of the class i.

[0017] According to such this invention, a packet by which tagging is not carried out in each buffer is received preferentially, by changing dynamically a packet transfer rate from each buffer according to class according to a traffic state in each buffer classified by class at that time, a weighting throughput guarantee corresponding to a class that secures each user a throughput more than a warranted band and to which a user belongs can be offered.

[0018]
[Embodiment of the invention] Next, the example of this invention is described using a drawing. Drawing 2 is a block diagram showing the example of composition of a boundary node and drawing 3, 4 5 are the block diagrams showing the example of composition of an internal node.
[0019] [Example 1] Drawing 2 is a block diagram showing the example of composition of a boundary node, 21 is the user research and data processing part, 22 is the traffic monitoring part, 23 is a class marking part, 24 is a violation tagging part and 25 is a packet transfer parts.
[0020] The user research and data processing part 21 notifies the class of service value equivalent to a user's warranted band where the packet belongs to the class marking part 23, when the contract information (warranted band) for every user is managed and a packet is received from a user. The traffic monitoring part 22 directs to perform tagging that shows violation to the packet to the violation tagging part 24, when a packet is received, a user's warranted band where the packet belongs is compared with the actual use band in the present time and the use band has exceeded the warranted band. The class marking part 23 carries out marking of the class of service value received from the user research and data processing part 21 to a

packet. The violation tagging part 24 performs tagging to a packet according to directions of the traffic monitoring part 22. The packet transfer part 25 transmits a packet.

[0021] Drawing 3 is a block diagram that shows the example of composition of an internal node, 31 is an arrival packet number Ai test part, 32 is a number Fi calculation part of flows, 33 is a number Fi management part of flows, 34 is a packet classification part, 35 is a transfer-rate Di calculation part, 36 is a packet storing part, 37 is a packet transfer part.

[0022] The arrival packet number Ai test part 31 measures the arrival rate Ai (bps) of the packet by which tagging is not carried out to every class i among the packets that arrived in the predetermined time intervals t (s), and notifies the result to the number Fi calculation part 32 of flows. The number Fi calculation part 32 of flows receives the packet arrival rate Ai of the class i from the arrival packet number Ai test part 31, the number Fi of active user flows of the class i is calculated by Fi<-(1-a) * Fi + a * Ai/Gi using Ai, and the number Fi management part 33 of flows is notified of a calculation result. Here, Gi (bps) is a warranted band of the class i, and a is a smoothing parameter. The number Fi management part 33 of flows receives the number Fi of active user flows of

the class i from the number Fi calculation part 32 of flows and manages the newest value. Fi is notified according to the directions from the transfer rate Di calculation part 35.

[0023] The packet classification part 34 transmits a packet to the class buffer concerned of the packet storing part 36 based on the class value by which marking was carried out by a boundary node. The transfer rate Di calculation part 35, predetermined cycle T (s), every value of Fi is read from the number Fi management part 33 of flows, the packet transfer rate Di (bps) from the buffer of the class i is calculated by Di=(Fi*Gi/S Fi*Gi) *C, and a result is notified to the packet transfer part 37. Here, c (bps) is an output link rate. The packet storing part 36 accumulates a packet according to a class, and takes out a packet from each class buffer according to the directions from the packet transfer part 37. The packet transfer part 37 reads and transmits a packet from each class buffer of the packet storing part 36 according to the packet transfer rate Di of the class i determined by the transfer rate Di calculation part 35.

[0024] [Example 2] Although the arrival rate Ai (bps) of the packet by which tagging is not carried out to every class i among the packets that are the arrival packet number Ai test parts 31 of the internal node shown on drawing 3 in Example 1, and arrived was

measured in the predetermined time intervals t (s), in this Example 2, the arrival rate Ai (bps) of the packet of the class i is measured in the predetermined time intervals t (s) among the packets that arrived. Others are the same as that of Example 1.

[0025] [Example 3] Drawing 4 is a block diagram that shows the example of composition of the internal node in Example 3, 41 is the waiting packet number Qi test part for transmission, 44 is a packet classification part, 45 is a transfer rate Di calculation part, 46 is a packet storing part and 47 is a packet transfer part.

[0026] The waiting packet number Qi test part 41 for transmission manages the number Qi of the packets by which tagging is not carried out among the packets that are waiting for transmission within the buffer of the class i of the packet storing part 46, when the packet of the class i arrives and Qi exceeds threshold Th defined preliminary, the value of the class j with the smallest value of the class value i and Qi is notified to the transfer rate Di calculation part 45. The packet classification part 44 transmits a packet to the buffer of the class of the packet storing part 46 based on the value of the class by which marking was carried out by a boundary node.

[0027] The transfer rate Di calculation part 45 from the waiting packet number Qi test part 41 for transmission. After Qi receives the notice of the value i beyond a threshold of a class, and the value j of the smallest class, the packet transfer rate Di (bps) from the buffer of the class i is made to increase by Di<-Di+d, the packet transfer rate Dj (bps) from the buffer of the class j is decreased by Dj<-Dj-d, and the result is notified to the packet transfer part 47. Here, d is a part for the rate increase and decrease defined preliminary. The packet storing part 46 accumulates a packet according to a class, and takes out a packet from the buffer of each class according to the directions from the packet transfer part 47. The packet transfer part 47 reads and transmits a packet from the buffer of each class of the packet storing part 46 according to the packet transfer rate Di of the class i determined by the transfer rate Di calculation part 45.

[0028] [Example 4] Although the number Qi of the packets by which tagging is not carried out among the packets that are waiting for transmission within the buffer of the class i of the packet storing part 46 was managed in Example 3 by the waiting packet number Qi test part 41 for transmission of the internal node shown on drawing 4, in this Example 4, the number Qi of the packets that are waiting for transmission

within the buffer of the class i of the packet storing part 46 is managed. Others are the same as that of Example 3.

[0029] [Example 5] Drawing 5 is a block diagram that shows the example of composition of the internal node in Example 5 51 is a packet loss rate Li test part, 54 is a packet classification part, 55 a transfer rate Di calculation part, 56 is a packet storing part and 57 is a packet transfer part.

[0030] The value of the class i with the largest value of the loss rate Li in which the packet loss rate Li test part 51 measures the loss rate Li of the packet in the buffer of the class i by which tagging is not carried out with a predetermined cycle in the packet storing part 56, the value of the class j with the smallest value of Li is notified to the transfer rate Di calculation part 55. The packet classification part 54 transmits a packet to the buffer of the class of the packet storing part 56 based on the value of the class by which marking was carried out by a boundary node.

[0031] After the transfer rate Di calculation part 55 receives the value of the class i with the largest value of the loss rate Li, and the value of the class j with the smallest value of Li from the packet loss rate Li test part 51, the packet transfer rate Di (bps) from the buffer of the class i is made to increase by Di<-Di+d, the packet transfer rate Dj (bps) from the buffer of the

class j is decreased by Dj<-Dj-d, and the result is notified to the packet transfer part 57. Here, d is a part for the rate increase and decrease defined preliminary. The packet storing part 56 accumulates a packet according to a class, and takes out a packet from the buffer of each class according to the directions from the packet transfer part 57. The packet transfer part 57 reads and transmits a packet from the buffer of each class of the packet storing part 56 according to the packet transfer rate Di of the class i determined by the transfer rate Di calculation part 55.

[0032] [Example 6] Although the loss rate Li of the packet in the buffer of the class i of the packet storing part 56 by which tagging is not carried out was measured with the predetermined cycle in Example 5 by the packet loss rate Li test part 51 of the internal node shown on drawing 5, in this Example 6, the loss rate Li of the packet in the buffer of the class i of the packet storing part 56 is measured with a predetermined cycle. Others are the same as that of Example 5.

[0033]

[Effect of the invention] Without performing status management for every user flow by an internal node according to this invention, as explained above, by performing detection of change of the number of user flows of each class or presumption of the number of

user flows and changing dynamically the packet transfer rate from the buffer of each class corresponding to change of the number of user flows, even when traffic conditions (here the number of active flows or the number mixture ratio of flows of each class) are changed, the weighting throughput guarantee corresponding to the class to which a user belongs, the throughput for the warranted band to each user is guaranteed and can be offered.

[Brief description of the drawings]

[Drawing 1] is a drawing showing the composition of a common Internet network.

[Drawing 2] is a block diagram showing the example of composition of a boundary node.

[Drawing 3] is a block diagram showing the example of composition of an internal node.

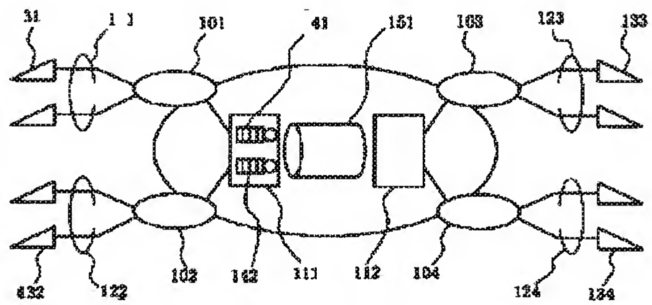
[Drawing 4] is a block diagram showing other examples of composition of an internal node.

[Drawing 5] is a block diagram showing the example of composition of further others of an internal node.

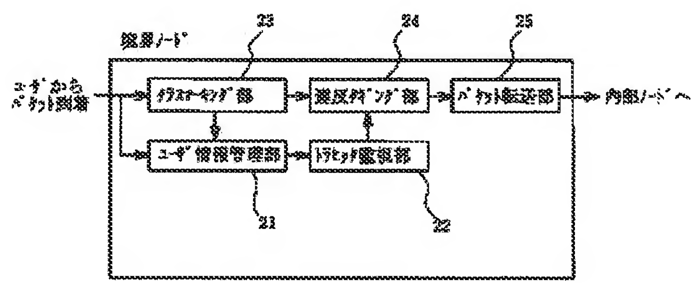
[Description of numerals]

21 User research and data processing part
22 Traffic monitoring part
23 Class marking part
24 Violation tagging part
25 Packet transfer part
31 Arrival packet number Ai test part
32 Number Fi calculation part of flows
33 Number Fi management part of flows
34, 44, 54 Packet classification part
35, 45, 55 Transfer-rate Di calculation part
36, 46, 56 Packet storing part
37, 47, 57 Packet transfer part
41 Waiting packet number Qi test part for transmission
51 Packet loss rate Li test part
101 - 104 Boundary node
111, 112 Internal node
121 TCP connection of the class 1
122 TCP connection of the class 2
123, 124 TCP connections
131-134 Terminal unit
141 The buffer of the class 1
142 The buffer of the class 2
151 Link

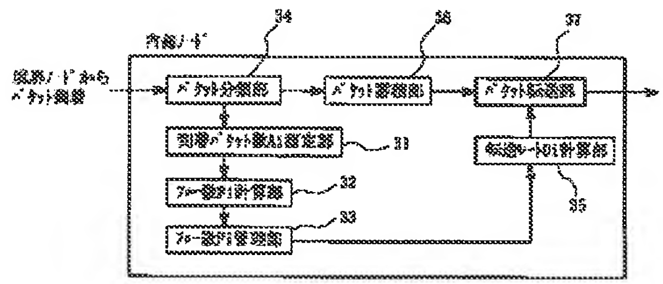
Drawing 1



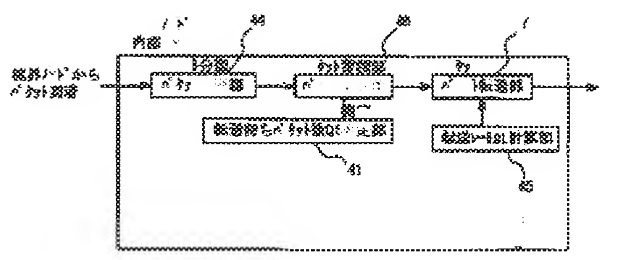
Drawing 2



Drawing 3



Drawing 4



Drawing 5